EXHIBIT 1

US009643706B2

(12) **United States Patent**
Knoblach et al.

(10) **Patent No.: US 9,643,706 B2**
(45) **Date of Patent: *May 9, 2017**

(54) **SYSTEMS AND APPLICATIONS OF LIGHTER-THAN-AIR (LTA) PLATFORMS**

(71) Applicant: **SPACE DATA CORPORATION**, Chandler, AZ (US)

(72) Inventors: **Gerald M. Knoblach**, Chandler, AZ (US); **Eric A. Frische**, Sun Lakes, AZ (US); **Bruce Alan Barkley**, Phoenix, AZ (US)

(73) Assignee: **SPACE DATA CORPORATION**, Chandler, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/351,438**

(22) Filed: **Nov. 14, 2016**

(65) **Prior Publication Data**

US 2017/0057607 A1 Mar. 2, 2017

Related U.S. Application Data

(60) Continuation-in-part of application No. 14/473,691, filed on Aug. 29, 2014, now Pat. No. 9,519,045, (Continued)

(51) **Int. Cl.**
B64B 1/40 (2006.01)
G05D 1/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B64B 1/40*** (2013.01); ***B64B 1/64*** (2013.01); ***B64B 1/70*** (2013.01); ***G01S 19/24*** (2013.01); ***G01S 19/42*** (2013.01); ***G05D 1/042*** (2013.01)

(58) **Field of Classification Search**
CPC H04Q 7/20; B64B 1/40
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,151,336 A 3/1939 Scharlau
2,366,423 A 1/1945 Pear, Jr.
(Continued)

FOREIGN PATENT DOCUMENTS

DE 1188951 3/1965
EP 0837567 A2 4/1998
(Continued)

OTHER PUBLICATIONS

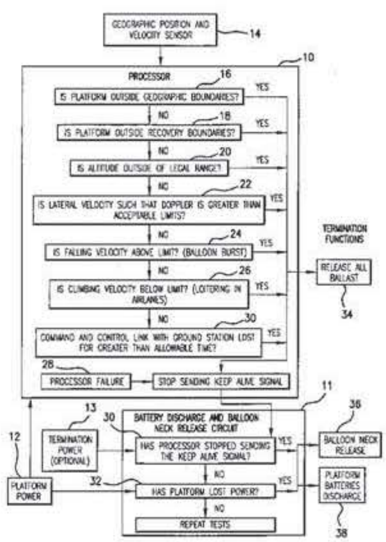
"Attunity Connect for Mainframe, Native OS/390 Adapters to Data and Legacy." 2003, pp. 1-3.
(Continued)

Primary Examiner — Thomas Tarcza
Assistant Examiner — Alex C Dunn
(74) *Attorney, Agent, or Firm* — Pillsbury Winthrop Shaw Pittman LLP

(57) **ABSTRACT**

Innovative new systems and method of operating the systems, wherein the system comprises an airborne platform comprising an unmanned balloon; a payload that is separate from the unmanned balloon; a transceiver; first and second flight termination devices; at least two separate power sources for the first and second flight termination devices; a sensor; a processor; a pump; a valve; and a tether that when broken separates the unmanned balloon and the payload, are disclosed herein.

30 Claims, 7 Drawing Sheets



the keep alive signal also ceases, causing termination. The timer advances to a point where it initiates the battery discharge. Battery current flows through the resistive wire discharging the batteries and melting through the monofilament to release the balloon neck. The battery discharge continues until the main batteries are completely dead.

The main platform batteries are fully discharged during descent and if needed upon landing to positively terminate and prevent further radio transmission. Once discharge is initiated, the batteries fully discharge eliminating the chance of transmitting with significant power. The battery discharge can be initiated by the processor as described above or automatically when power or processor control is lost. It has been found that long duration platform flight at high altitudes and cold temperatures requires special high-density power and functional capabilities at low temperatures. It has been found that lithium batteries beneficially fulfill such requirements. Additionally, it was found that the Environmental Protection Agency (EPA) states that lithium based batteries are considered hazardous waste except for one type of cell and only when fully discharged. Particularly it has been found that Lithium Sulfur Dioxide (LiSO2) batteries, when fully discharged, form a lithium salt, which is not considered hazardous by the EPA. Automatically discharging the LiSO2 batteries before they contact the ground not only prevents the transmitter from transmitting but also renders the batteries non-hazardous for environmentally acceptable landing on the ground.

Use of a novel and integral "maple seed" like descent device to increase safety is depicted in FIGS. **6**, **7** and **8**. A single airfoil shaped blade attached to the bottom of the platform causes autorotation of the payload and airfoil blade upon rapid descent. This replaces a traditional parachute with a highly reliable decelerator that is generally immune to fouling than a parachute and less complex. No deployment mechanism is necessary and it is immune to the fouling problems with animals after descent. The "maple seed" decelerator may also be used to conveniently house the platform antenna.

A novel method of platform recovery is depicted in FIG. **9**. To aid in the recovery of the platform, the landed platform sends its last recorded position to an additional airborne platform using a low power transmitter and tiny battery. The transmitter might utilize one of the low power unlicensed bands to send the information. The second platform relays the current location of the landed platform to the ground station to aid in recovery.

What is claimed is:

1. A system comprising an airborne platform comprising an unmanned balloon comprising a gas enclosure;

a pump and a valve;

a GPS configured to determine current geographical coordinates of the unmanned balloon;

a payload comprising a transceiver, wherein the transceiver is capable of communicating with communication devices that are separate from the unmanned balloon and include a communication device on the ground and a payload of another operational unmanned balloon, wherein, in operation, the unmanned balloon substantially drifts along with wind currents;

first and second flight-termination devices each configured to cause termination of a flight of the unmanned balloon; and

at least two power sources each configured to provide power to at least one of the first and second flight-termination devices;

wherein the unmanned balloon is configured to be operational above an altitude of about 60,000 feet, and wherein a transmitter operationally related to the unmanned balloon is configured to provide a last recorded position of the unmanned balloon such that the last recorded position is sent to a station to aid in recovery of the unmanned balloon.

2. The system of claim **1**, wherein at least one of the first and second flight-termination devices is configured to independently cause termination of the flight of the unmanned balloon when further operation of the unmanned balloon presents danger to air traffic.

3. The system of claim **2**, wherein at least one of the first and second flight-termination devices is configured to cause termination of the flight of the unmanned balloon based on a rise rate or a fall rate of the unmanned balloon.

4. The system of claim **1**, wherein at least one of the first and second flight-termination devices is configured to independently cause termination of the flight of the unmanned balloon based on a malfunction related to the unmanned balloon.

5. The system of claim **4**, wherein the malfunction includes failure of a processor of the unmanned balloon.

6. The system of claim **4**, wherein the malfunction includes failure of a power source of the unmanned balloon.

7. The system of claim **4**, wherein the malfunction includes failure of the GPS of the unmanned balloon.

8. The system of claim **1**, the system further comprising a tether that when broken separates the gas enclosure and the payload.

9. The system of claim **1**, wherein the system comprises a plurality of the airborne platforms.

10. The system of claim **1**, wherein the payload remains attached to the unmanned balloon as one when landed unless the payload is separated from the unmanned balloon.

11. The system of claim **1**, the system further comprising an antenna.

12. The system of claim **1**, wherein the pump and the valve are configured to change an altitude of the airborne platform.

13. The system of claim **1**, the system further comprising a pump and a valve, wherein the payload remains attached to the unmanned balloon as one when landed unless the payload is separated from the unmanned balloon, and wherein the pump and the valve are configured to change a position of the airborne platform.

14. A system comprising an airborne platform comprising an unmanned balloon comprising a gas enclosure;

a GPS configured to determine current geographical coordinates of the unmanned balloon;

a payload comprising a transceiver, wherein the transceiver is capable of communicating with communication devices that are separate from the unmanned balloon and include a communication device on the ground and a payload of another operational unmanned balloon, wherein, in operation, the unmanned balloon substantially drifts along with wind currents; and

a first flight-termination device configured to cause termination of a flight of the unmanned balloon based at least on a determination that further operation of the unmanned balloon presents danger to air traffic,

a tether that when broken separates the gas enclosure and the payload,

wherein the unmanned balloon is configured to be operational above an altitude of about 60,000 feet and wherein a transmitter operationally related to the unmanned balloon is configured to provide a last

recorded position of the unmanned balloon such that the last recorded position is sent to aid in recovery of the unmanned balloon.

15. The system of claim **14**, the system further comprising a second flight-termination device configured to cause termination of the flight of the unmanned balloon; and at least two power sources each configured to provide power to one of the first and second flight-termination devices.

16. The system of claim **15**, wherein the second flight-termination device is configured to cause termination of the flight of the unmanned balloon when the first flight-termination mechanism has failed.

17. The system of claim **15**, wherein at least one of the first and second flight-termination devices is configured to cause termination of the flight of the unmanned balloon based on a rise rate or a fall rate of the unmanned balloon.

18. The system of claim **15**, wherein at least one of the first and second flight-termination devices is configured to cause termination of the flight of the unmanned balloon based on a malfunction of the unmanned balloon.

19. The system of claim **18**, wherein the malfunction includes failure of a processor of the unmanned balloon.

20. The system of claim **18**, wherein the malfunction includes failure of a power source of the unmanned balloon.

21. The system of claim **18**, wherein the malfunction includes failure of the GPS of the unmanned balloon.

22. The system of claim **14**, the system further comprising an antenna.

23. The system of claim **14**, the system further comprising at least two geographical coordinates tracking system.

24. The system of claim **14**, wherein the system comprises a plurality of the airborne platforms.

25. The system of claim **14**, wherein the payload remains attached to the unmanned balloon as one when landed unless the payload is separated from the unmanned balloon.

26. The system of claim **14**, the system further comprising a pump and a valve.

27. The system of claim **15**, wherein the pump and the valve are configured to change an altitude of the airborne platform.

28. The system of claim **14**, the system further comprising a pump and a valve, wherein the payload remains attached to the unmanned balloon as one when landed unless the payload is separated from the unmanned balloon, and wherein the pump and the valve are configured to change a position of the airborne platform.

29. A system comprising an airborne platform comprising an unmanned balloon; a payload that is separate from the unmanned balloon; a transceiver; first and second flight termination devices; at least two separate power sources for the first and second flight termination devices; a sensor; a processor; a pump; a valve; and a tether that when broken separates the unmanned balloon and the payload;

wherein the pump and the valve are configured to change an altitude of the airborne platform;

wherein the sensor comprises a pressure sensor;

wherein, in operation, the unmanned balloon substantially drifts along with the wind currents;

wherein the transceiver is capable of communicating with a communication device that is separate from the unmanned balloon;

wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon;

wherein at least one of the geographical coordinates tracking system comprises a GPS;

wherein the unmanned balloon is configured to operate above an attitude of about 60,000 feet;

wherein the unmanned balloon has a flight duration capability that is longer than that of weather balloons that have flight durations of approximately 2 hours;

wherein the payload is configured to communicate with an additional airborne payload attached to a separate unmanned balloon;

wherein the payload remains attached to the unmanned balloon as one when landed unless the payload is separated from the unmanned balloon;

wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon based on a determination that further operation of the unmanned balloon presents a danger to air traffic; and

wherein each of the first and second flight termination devices has an ability to independently terminate a flight of the unmanned balloon based on a determination of a malfunction of the unmanned balloon.

30. The system of claim **29**, the system further comprising an antenna and at least two geographical coordinates tracking system.

* * * * *

*The relevant asserted claims are highlighted. In addition, claim 14 is highlighted because asserted claim 24 depends from it.

Exhibit 2 also illustrates both the relevant asserted claims and claim 14.